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DEPARTMENT OF THE ARMY
ARMY CONCEPT TEAM IN VIETNAM
APO San Francisco 96384

CLARK RANGER FORKLIFT (CRF)

ACL-29/68I

DEPARTMENT OF THE ARMY
ARMY CONCEPT TEAM IN VIETNAM
APO San Francisco 96384

AVIB-CO

2 October 1968

SUBJECT: Final Report - Clark Ranger Forklift (CRF)

Commanding General
United States Army, Vietnam
ATTN: AVHGC-DST
APO 96375

1. Reference: Letter, AVHGC-DH, Headquarters, US Army, Vietnam, 23 February 1967, subject: Letter of Instruction.

2. In accordance with the provisions of the foregoing reference, the attached final report is forwarded for review and transmittal to Department of the Army.

3. Request one copy of the USARV and CINCUSARPAC forwarding indorsement be furnished the Commanding Officer, Army Concept Team in Vietnam (ACTIV).

FOR THE COMMANDER:

Norman M. Leary

NORMAN M. LEARY
CPT, AGC
Adjutant

DEPARTMENT OF THE ARMY
ARMY CONCEPT TEAM IN VIETNAM
APO San Francisco 96384

FINAL REPORT

CLARK RANGER FORKLIFT

ACTIV Project No. ACL-29/68I

2 October 1968

Approved:

C. J. MOLLOY JR.
Colonel, Infantry
Acting Commander

AUTHORITY

USARV Message AVHGC-DST 93364, 21 December 1967, subject: Forklift, 4000 lb Capacity, Clark Ranger (ENSURE 93).

ACKNOWLEDGMENTS

The Army Concept Team in Vietnam is indebted to the 1st Aviation Brigade for its assistance in the evaluation

PROJECT OFFICER

LTC Earl C. Carlson, Transportation Corps

CONTENTS

SUMMARY

This evaluation was to determine the suitability of the Clark Ranger Forklift (CRF) for use in the Republic of Vietnam (RVN). The evaluation was limited to units of the 1st Aviation Brigade. These units were located throughout RVN and the forklift was used in partially prepared areas under various terrain and climatic conditions in RVN.

The CRF was used primarily for moving aircraft parts and supplies in the transportation detachments which support aviation companies. They were also used for base improvement, moving CONEX containers, towing aircraft, and other suitable tasks.

The CRF was operated by personnel usually selected because their regular jobs required use of the forklift. Little training was necessary.

The CRF performed well, was rugged, easy to operate, and appeared to be reliable during the brief evaluation period. However, substantial improvements could be made by a few simple modifications. Several major modifications are required if the CRF is to be effective in rough terrain. For those areas where the greatest percentage of the daily work load consists of operating on various surfaces which are fairly even, the CRF can be a valuable addition to the materials handling equipment in the Army inventory.

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I. INTRODUCTION

A. PURPOSE

The purpose of this evaluation was to determine the suitability of the Clark Ranger Forklift (CRF) for use in the Republic of Vietnam (RVN).

B. OBJECTIVES

1. Objective 1 - Performance

   Determine the operational effectiveness of the CRF in RVN.

2. Objective 2 - Reliability

   Determine the reliability of the CRF in RVN.

3. Objective 3 - Supportability

   Determine the supportability of the CRF in RVN.

4. Objective 4 - Acceptability

   Determine user acceptability of the CRF in RVN.

C. SCOPE

Twenty-five Clark Ranger Forklifts were evaluated in various transportation maintenance detachments of the 1st Aviation Brigade. The forklifts were utilized on and off prepared areas during the dry and monsoon seasons. The evaluation was based on the performance of normal tasks by the CRF in the maintenance detachments, each of which has its own supply and storage operation. No attempts were made to simulate possible hazards. The evaluation was not permitted to interfere with combat support operations. During the 60-day period, maintenance problems which may be expected to develop later in the life of the equipment were not experienced. Consequently, the potential implications of those problems could not be evaluated. Its ability to operate in sand, mud, rough terrain, and other unfavorable conditions was evaluated as was its ability to handle loads of various size, shape, and weight normally encountered in support operations. Additionally, design characteristics, speed, ease of operation, safety considerations, and requirements for modification were examined.

D. BACKGROUND

1. Project History

In April 1966, the 1st Aviation Brigade submitted an Expedited Non-Standard Urgent Requirements for Equipment (ENSURE) request for 65 forklifts. Under Procurement of Equipment and Missiles, Army (PEMA), Project 40403, personnel from US Army Natick Laboratories had previously visited various Army depots to determine materials handling equipment modernization requirements. Equipment being used was found to be unsatisfactory in unprepared, semi-prepared, or semi-rough terrain. The CRF was evaluated and found to be satisfactory for unimproved areas. The ENSURE request was approved 27 June 1966, and the Army Materiel Command proposed procurement of the 4000-pound capacity CRF. USARV concurred. In March 1968, 65 forklifts arrived in country. However, ship diversions, distribution delays, and other problems resulting from the Tet offensive delayed the evaluation until 1 May.

2. Materiel Description

The CRF is a gasoline engine driven, 4000-pound capacity forklift truck. It is articulated, has high flotation pneumatic tires and can be used in either two- or four-wheeled drive. It is 198 inches long, 72 inches wide, 102 inches high, and weighs 9,345 pounds empty. Its outside turning radius is 164 inches; its inside turning radius is 52 inches. The ground clearance is twelve inches. It has four forward and four reverse gears; its top speed loaded is 22 mph. The forks are adjustable by hand to a maximum spread of 60 inches. It has a tow pintle on the rear with a 5676-pound draw bar pull capability. The CRF is powered by a six cylinder, L-head, aircooled Continental engine. The lift is hydraulically operated. The hydraulic system is powered by a gear-driven vane-type pump. The system is protected by a built-in pressure relief valve. The forklift is capable of operating on unprepared surfaces, sand, mud, and inclines. It is classified as a semi-rough terrain forklift. (See figure 1.)

FIGURE 1. Clark Ranger Forklift

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II. EVALUATION DESIGN

A. DESIGN DEVELOPMENT

The forklifts were distributed to transportation maintenance detachments in the 1st Aviation Brigade to handle aircraft parts and supplies and for other appropriate tasks. The CRF was used by operators trained within the unit and was maintained by motorpool mechanics. No special instructions, tools, or parts were provided other than those in the factory pack. Maintenance problems were resolved through normal command and maintenance channels. Standard maintenance records were kept on the forklifts and standard procedures on operation and maintenance were in effect.

B. PROJECT ENVIRONMENT

The forklifts were distributed to selected units throughout RVN. They were used in the soft sand of the coastal plains, in the wet red clay of the central highlands, and in the mud of the delta area. They were received during the dry season and used through the initial stages of the monsoon season. Although most of the time the forklifts were operated on improved areas or parking ramps, they were frequently used by some units in off-ramp areas including mud, sand, and moderately rough terrain.

C. RESOURCES

There were no full-time evaluators or data collectors. Each maintenance detachment commander was asked to collect data, to provide subjective comments, and to recommend modifications based on his unit's experience with the forklift. Operators were also used as data collectors. No special equipment was required.

D. DATA COLLECTION

The ACTIV Project Officer delivered questionnaires and instructional material to each unit commander evaluating the forklift. The questionnaires were filled out at the termination of the evaluation period and were forwarded along with comments and maintenance records to the ACTIV Project Officer. The questionnaires and maintenance data were reviewed and those which appeared contradictory were further investigated. The ACTIV Project Officer revisited those units from which data appeared contradictory, out of perspective, or unfounded. Unit commanders, maintenance officers, mechanics, and operators were queried. Equipment was taken out into the usual operating areas and specific tests conducted to determine the validity of data collected. Personal interviews were conducted to supplement data collected through questionnaires.

E. DATA ANALYSIS

Data collected was separated into two groups: statistical data and subjective comments. All data was analyzed in terms of the objectives of the evaluation.

III. CONDUCT OF THE EVALUATION

A. OBJECTIVE 1 - PERFORMANCE

1. General Performance

The CRF was used primarily for moving aircraft parts and supplies of the transportation maintenance detachments supporting aviation companies of the 1st Aviation Brigade throughout RVN. Although used primarily on the aircraft ramp and in the supply yard, the CRF was also used for area development, towing aircraft, and other tasks for which it was suited. It was able to traverse areas with sand up to twelve inches deep if no sharp turns were made. However, the CRF could not maneuver satisfactorily in soft sand when the firm base was below six or seven inches. It could maneuver in and around ditches and in the mud but had difficulty maintaining traction on muddy inclines. It had difficulty negotiating ditches transversely with a load. However, it performed well with most loads in normal areas.

2. Cargo Moving Capability

A majority of the units reported that the CRF could perform the operations for which it was designed and evaluated. Figure 2 describes the unit's appraisal of the CRF's ability to handle cargo based on weight, shape and size.

Percentage of potential cargo within the capability of the CRF to handle.	Number of units reporting capability to move cargo based on:		
	Weight	Shape	Size
More than 95%	23	25	22
90 - 94%	1	0	2
80 - 89%	1	0	1
79% or less	0	0	0

FIGURE 2. Cargo-moving capability of the CRF.

3. Mobility

Most of the units normally operated on prepared surfaces in storage or maintenance areas or on the aircraft ramp. Most of these areas were suitable for commercial vehicles of various types and could not be considered rough terrain. However, in many areas the CRF was used in sand (ranging from firm to very soft and deep), in mud, and in unprepared areas which were moderately rough. Limitations of the CRF in various types of terrain are discussed in the following paragraph under Design Limitations and in annex A. Figure 3 describes the percentage of the operational areas which were usable by the CRF as reported by the evaluating units.

Percentage of total operating areas which were negotiable by the CRF.	Number of units reporting negotiable areas based on:			
	Sand	Mud	Inclines	Other
More than 95%	23	23	23	23
90 - 95%	0	1	2	1
80 - 89%	1	1	0	1
79% or less	1	0	0	0

FIGURE 3. Operational area capability of the CRF.

Twenty-eight percent of the units reported that the performance of the CRF was limited by design characteristics. Complaints included comments on the suspension system, limited soft sand capability, length of the forks, and inability to level the forks in uneven terrain. These limitations are discussed in annex A. It should be noted that these design limitations affected a very small percentage of the total or potential work load expected of the forklift. With the exception of the fork length, the design limitations refer to the forklift's rough or semi-rough terrain capability.

5. Ease of Operation

The units evaluating the forklift agreed that the CRF was one of the easiest to operate and best handling pieces of equipment with which they had worked.

6. Speed

There were no complaints on the speed limitations or characteristics of the CRF. All units stated that the speed was adequate for the jobs to be performed. Its suspension system, however, precluded its operation in high gear anywhere except on well-prepared surfaces because of the bouncing effect created by even moderately rough terrain.

7. Location of Controls

Ninety-six percent of the reporting units were satisfied with the location, response, and design of the forklift controls other than the hand brake, foot brake, and clutch. Both the brake and clutch pedal designs were unsatisfactory. When either was let out, the operator's knees were forced up against the underside of the steering wheel unless the operator spread his knees sufficiently (see figure 4).

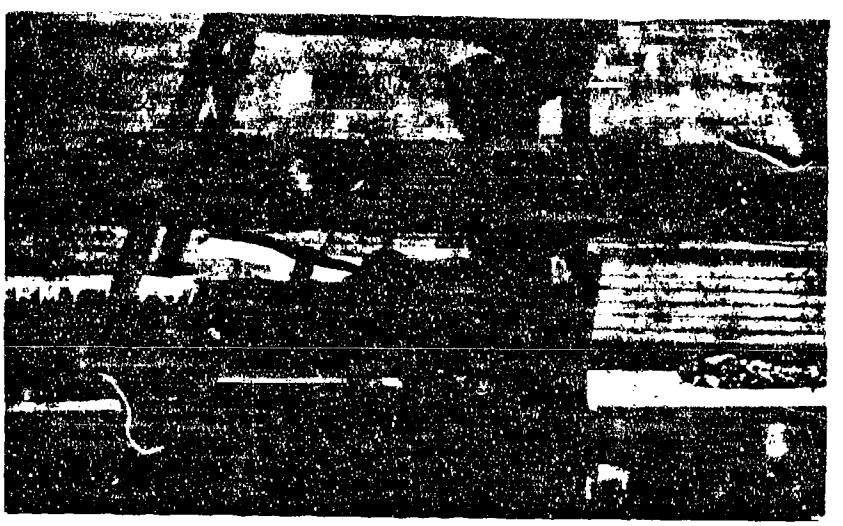


FIGURE 4. Design of clutch and brake pedals.

This not only was awkward and bothersome, but presented a potential safety hazard. The position of the hand brake was unsatisfactory (see annex B). Because of its awkward position, many drivers moved it part way by hand, then kicked it over the rest of the way (see figure 5). This subjected the handle to abuse and damage and also denied other use of that foot at critical moments.

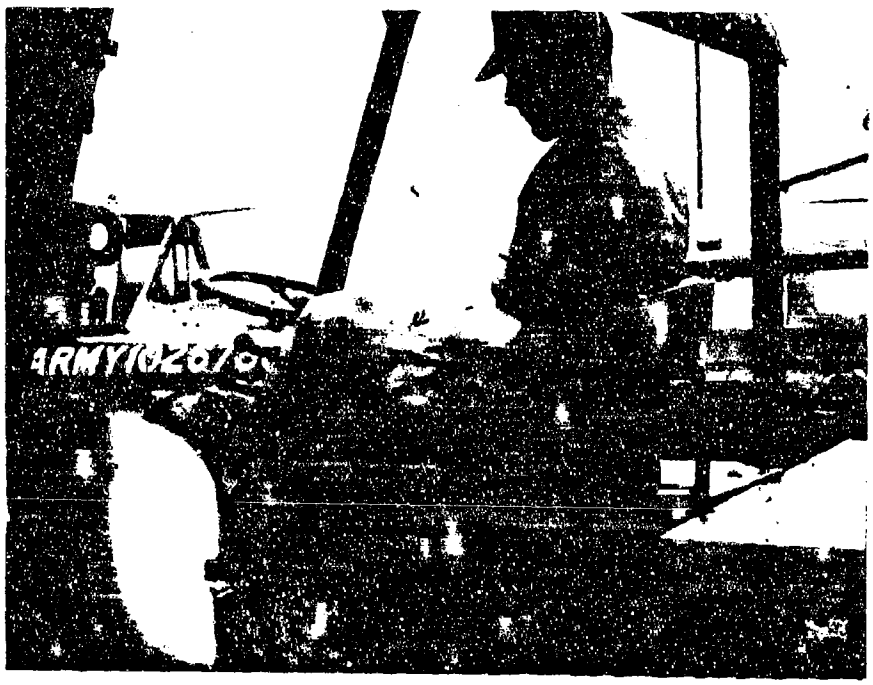


FIGURE 5. Placement of the hand brake.

8. Safety

a. Twenty-four percent of the using units considered one or more aspects of the forklift to be unsafe.

b. The most frequently mentioned unsafe item was the position of the brake and clutch pedals discussed in the preceding paragraph.

Serious injury or damage to cargo could result if the driver got his legs wedged between the pedals and the steering wheel during a critical operation.

c. Two units reported that their operators received head injuries while operating in semi-rough terrain. The suspension characteristics discussed in annex A were such that the operator was rather severely jostled while operating over uneven terrain, even at moderate speeds.

d. The hand brake, discussed in paragraph 7, presented a potentially hazardous condition. When operating on inclines with loads or in tight places, it often became necessary to play the hand and foot brakes to obtain desired results. The positioning of the hand brake and the force needed to apply it made it difficult to use and of limited value in critical situations.

9. Findings

a. Using units rated the prepared-area capability of the CRF high. Over 90 percent of the units reported it could negotiate at least 95 percent of their overall area and perform 95 percent or more of the tasks expected of it.

b. Twenty-eight percent of the units reported one or more characteristics of the CRF which limited its usefulness to them to some degree. No unit stated that the CRF was unsuitable because of these limitations.

c. CRF operators were unanimous in expressing their approval of its ease of operation and speed range.

d. The locations of the CRF controls were generally considered satisfactory with the exception of the clutch and brake pedals and the hand brake.

e. Twenty-four percent of the units suggested one or more improvements to make the operation of the CRF safer.

B. OBJECTIVE 2 - RELIABILITY

1. General

The reliability of the CRF could be determined only to a limited degree. The hours the equipment had been operated at the end of the evaluation ranged from 26 to 350. It was, therefore, impossible to determine the problems which might be expected to develop during the lifetime of the equipment. However, the CRF was relatively free of problems other than some experienced with the electrical system. During the period of evaluation, units in the field reported the CRF to be very reliable.

The CRFs being evaluated were operated for an average of 187 hours. See figure 6 for a breakdown of operating hours.

Number operated less than 100 hours	- 5
Number operated from 100 to 200 hours	- 8
Number operated from 200 to 300 hours	- 8
Number operated over 300 hours	- 4

FIGURE 6. Hours CRF operated during evaluation.

2. Electrical System

a. Most of the complaints regarding reliability of the CRF involved the electrical system. It was not possible within the scope of this evaluation to determine whether the electrical problems experienced were peculiar to and caused by the heat and moisture conditions in RVN. They may represent a general unsuitability of the electrical system of the CRF for continuous exposure to the elements. In either case, the number of failures appeared to be excessive for the first 60 days and 200 hours of operation.

b. Many units commented on the need to clean the corrosion from electrical connectors and wiring and in some cases to replace them. Coating the wires and terminals prior to shipment might eliminate the problem.

c. Three generators, three voltage regulators, and three starters were reported inoperative during the first 100 hours of operation. The failures were distributed among six units scattered through RVN. No perceptible pattern appeared.

d. Several units commented on the location of the ignition switch and the fact that no "off" or "on" position was visible (see figure 7). Consequently, the switch was often left on inadvertently, causing the battery to discharge.

3. Hydraulic System

a. One unit reported the failure of three "O" ring seals. However, the forklift was loaned to another unit at the time and it could not be determined whether the equipment was being used within its design capabilities.

FIGURE 7. Ignition switch location.

b. Several units reported miscellaneous hydraulic leaks but no significant problems were reported in the hydraulic system during the evaluation period. Two failures of Hydraulic Valve FSN 2330-019-2255 at less than 75 operating hours were reported.

4. Engine

a. No problems were reported on the fuel or ignition systems other than the ignition switch previously discussed in paragraph B 2.

b. One unit reported that the head gasket was blown upon receipt of the CRF. No other faults or problems were reported on the engine during the evaluation period.

5. Clutch and Transmission

a. The 256th Transportation Detachment reported a clutch failure after 254 hours of operation. This was the same unit which reported failure of three "O" ring seals discussed in paragraph B 3. The CRF was temporarily on loan and a positive determination could not be made as to whether the CRF was being used within its design limitation.

b. No problems were reported with the transmission.

c. One unit reported the clutch pedal was sticking because dirt was getting into the clutch pedal torque bar bearing attached to the frame at the junction of the clutch pedal arm and the torque bar.

6. Forks and Mast Assembly

No failure of any component of the mast assembly was reported. Comments on the forks referred to design limitations, not to reliability.

7. Wheels, Brakes, and Miscellaneous Components

The 408th Transportation Detachment reported continuous loss of brake fluid. However, a check with other units indicated that they did not experience similar problems. No leaks were found in the brake lines. No other problems were reported with wheels, brakes, or other miscellaneous components.

8. Ruggedness

There were no reports of components of the CRF being damaged as a result of the treatment to which it was subjected.

9. Findings

a. The CRF was used for only a limited number of hours, consequently no assessment could be made of its long-range reliability.

b. Nine major electrical components failed during the evaluation period and several additional electrical problems were noted.

c. No significant problems indicating a failure trend were reported on the engine, transmission, hydraulic system, or other components.

d. No reports were received indicating a lack of ruggedness of the CRF.

C. OBJECTIVE 3 - SUPPORTABILITY

1. Parts

Availability of parts for the CRF was a problem but not greater than for other equipment in country. Over 200 CRF parts had a Federal Stock Number, many of which were already in country. There were no indications that parts supply would be a problem even though a demand rate could not be established. Ninety percent of the units reported that no downtime days were experienced during the evaluation period due to lack of parts. Replacement of batteries presented a problem because the long slender batteries used by the CRF were not commonly used and were not readily available.

2. Maintenance

a. Since the CRF was new and the evaluation period only 60 days, very limited maintenance was required. However, experience gained during the evaluation did not indicate any potential maintenance problems.

b. Repeated failures of components of systems were reported by 16 percent of the evaluating units. Additional random failures were noted.

(1) The electrical system discussed in paragraph B (Reliability) accounted for half the repeated failures and nearly half of the random failures or problems.

(2) The two large bolts which hold the rear deck cover plate to the main frame had no self-locking device. As a result, the bolts often vibrated loose and sometimes were lost (see figure 8).

c. No problems were reported on routine maintenance of the CRF. User maintenance and service functions were within the capability of the operators and mechanics.

d. An average of two discrepancies per CRF was reported during the evaluation period. Downtime for maintenance varied from two hours to six days. The average reported downtime for maintenance during the 60-day evaluation period was 25 hours.

3. Servicing

a. Standard fuel, oil, and hydraulic fluid were used and no POL support problems were reported.

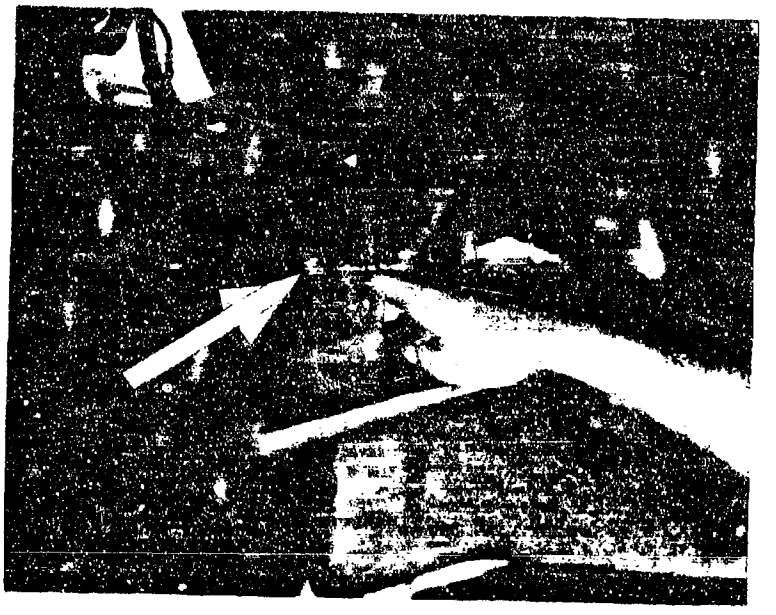


FIGURE 8. Rear deck attaching bolts

b. The fuel filler neck is smaller than many of the fuel nozzles used on military fuel trucks (see figure 9). Consequently, if a suitable funnel was not handy, fuel was spilled and time was wasted refueling.

4. Findings

a. The unique shape of the battery presented the only significant repair part supply problem.

b. Repeated failures were reported by 16 percent of the evaluating units.

FIGURE 9. Fuel filler neck.

c. The most frequently reported problem area with the CRF was the electrical system.

d. There were no reports of maintenance problems caused by mud or dust.

e. The fuel tank filler neck could not receive some Army fuel nozzles.

D. OBJECTIVE 4 - ACCEPTABILITY

1. General

The CRF was well received in the field by operators, commanders,

and maintenance officers. Its ease of operation, simplicity of design and function, and versatility were acknowledged by operators, NCOs, and commanders. The CRF was judged easy to operate by all evaluating units. No special training was required.

2. Operators' Comments

a. The most common operators' complaint was the difficulty of getting the forward-reverse gear from one position to the other. Unless the engine and the gears were synchronized, there was a loud clash and grinding of gears and it was difficult to move the shift lever. Even when the CRF was stationary with the engine idling it was difficult to move the gear from forward to reverse or vice versa.

b. Numerous complaints were received on the position of the hand brake. A discussion of the hand brake is contained in paragraph A 7.

c. The design of the forks was considered marginal by many operators. The principal complaint was that they would not lock in place. Consequently, even when working with standard size pallets the operators had to dismount and adjust the forks each trip before picking up a load when operating on bumpy ground. Vibration caused the forks to slide or float back and forth on their support member unless held in place by a load. Additional complaints included inability to determine where the ends of the forks were with relation to the load, and inability to handle some loads because of the shortness of the forks (see annex A).

d. Vibration of the CRF when operating on rough terrain was uncomfortable and fatiguing. While operating over rough ground several operators received head injuries caused by the tossing motion of the CRF. A washboard type surface was especially hard on the operator.

3. Commanders' Comments

a. Several commanders expressed concern over the design of the clutch and brake pedals discussed in paragraph A 7. They were concerned that control could temporarily be lost if the operator got his knees wedged against the steering wheel in a critical operation.

b. Neither commanders nor operators were satisfied with the small size of the fuel filler neck.

4. Suggested Modifications

A number of modifications were suggested to correct minor problems on the CRF or to improve it and make it more acceptable. None was considered mandatory for satisfactory operation over prepared surfaces. Areas which do not contain deep, soft sand, muddy inclines over 25 percent,

ditches over twelve inches deep, very rough surfaces, stumps, rocks, and other sizeable obstacles, can be negotiated by the CRF.

a. Major Modifications

(1) Several unit commanders recommended that the suspension system be re-engineered if the CRF is to be an effective semi-rough terrain forklift. Changes should include a load-leveling capability and independent movement of the forks.

(2) Several recommendations were received that a 24-volt electrical system be installed and that a standard size battery be used. Recommendations were received to replace the starter, generator, and voltage regulator with models designed for hot, humid climates. It was recommended that the ignition switch be relocated to a position where it can be easily seen and that the "off" and "on" positions be clearly marked. A small red warning light should be added to remind the operator to turn the switch off.

b. Miscellaneous Modifications

(1) Several operators and commanders recommended that a simple modification be made to lock the forks in place. The lock should be easy to engage and disengage.

(2) No assessment could be made of the damage done by the clashing gears when shifting back and forth from forward to reverse. However, consideration should be given to installing gears which will mesh more easily and quietly.

(3) Relocation of the hand brake to a position just below the operator's seat on the left side was recommended.

(4) Numerous suggestions were made that the brake and clutch pedals be shortened to reduce the travel and improve leg room.

(5) Enlargement of the fuel filler neck was repeatedly recommended.

5. Findings

a. The general consensus of the operators and commanders in the field was that the CRF is simple and easy to operate.

b. Operators' complaints included problems with the reverse-forward gear, hand brake, forks, and vibration of the CRF when operating over rough ground.

c. Commanders and operators were concerned over the unsatisfactory design of the clutch and brake pedals.

d. Recommendations were made for the modification of the suspension system, electrical system, and a number of minor items.

E. CONCLUSIONS

1. The CRF performed most of the tasks expected of it by aircraft maintenance detachments in RVN and was satisfactorily operated in most of the areas utilized by most of these units.

2. The CRF was not suited for work in deep, soft sand characteristic of much of the seacoast of RVN nor in very rough, uneven ground.

3. The CRF was rugged and reliable within the first 300 hours of its life.

4. Electrical components, especially the starter, generator, and voltage regulator, did not perform well during the evaluation in many of the units.

5. The CRF was satisfactorily supported in RVN under field conditions.

6. Commanders and operators in the field were enthusiastic about the simplicity, utility, and dependability of the CRF.

7. Although the CRF was acceptable for limited use, certain modifications should be made before quantity procurement is begun.

8. Several major modifications are required to make it suitable for a wider range of use.

F. RECOMMENDATIONS

1. That the CRF be considered suitable for use in areas which are fairly even and free of deep, soft sand.

2. That modifications as recommended in annex B be completed prior to quantity procurement.

ANNEX A

DESIGN LIMITATIONS AFFECTING
MISSION PERFORMANCE

1. SUSPENSION SYSTEM

Operational units reported that the CRF was unable to operate at speeds over five mph over moderately rough terrain because of the design of the suspension system. This fact was confirmed by the project officer who found an unacceptably high vibration and bounce rate at speeds below five mph over some types of moderately rough ground. Tests were conducted on hard, moderately rutted ground and pierced steel planking which was imperfectly laid but suitable for operating various trucks. In most of the areas in which the forklifts were operated, however, the roughness of the terrain was not a limiting factor.

2. TIRE FLOTATION IN SOFT SAND

The forklift was unable to operate in extremely soft sand characteristic of the beaches of RVN (see appendix 1). However, it was seldom necessary to operate in deep sand in the areas occupied by most of the aviation units. The forklift operates well in moderately soft sand if sharp turns are avoided but once it breaks through the surface in deep, soft sand, a bouncing effect begins in which the tires alternately gouge sand, then skip. This effect, which appears to be partially caused by the CRF's suspension characteristics, could probably be minimized by a combination of an improved suspension system and a better tread on the tires. The 151st Transportation Detachment, operating on the sandy beaches of Chu Lai, reported that 20 percent of their area could not be negotiated by the forklift.

3. FORK LENGTH

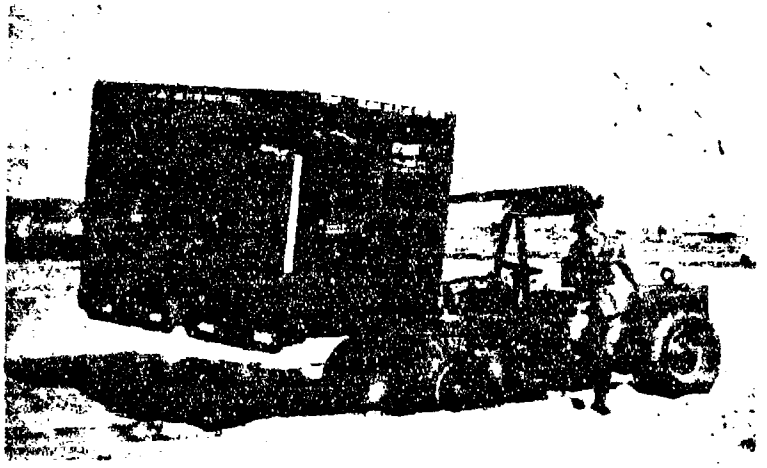
In several instances, the short forks were cited as a limiting factor in handling some loads. Large containers such as a CH-47 transmission, although liftable, balanced so precariously as to be unsafe to haul (see appendix 2). Further, pallet loads could not be removed from stake and platform trucks if they were loaded in the center of the truck. The percentage of operations limited by the length of the forks was relatively small, constituting less than five percent of the workload. However, a 24-inch extension would further increase the forklift's utility.

4. FORK LEVELING

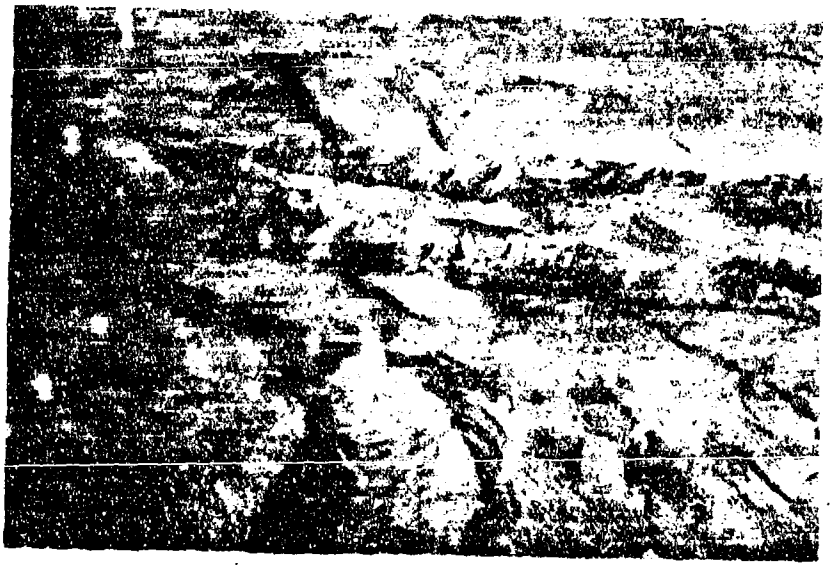
Inability to adjust the forks to the load in rough terrain constituted one of the more serious limitations of the forklift as a semi-rough terrain forklift. Most loads could eventually be picked up after up to five minutes of manipulation and some risk of damaging the load (see appendix 3). A further limitation of nonadjustable forks existed in the inability of the CRF to move large crates over rough ground, especially transversely over ditches. Again, this applied to a very small percentage of the forklift's mission.

5. HEIGHT OF MAST

The height of the mast precluded loading and unloading CH-47 helicopters with the CRF. The rear overhang of the CH-47 fuselage precludes raising the lift when the forklift is driven to the rear door loading ramp (see appendix 4).



The CRF could move across fairly deep sand until a turn was initiated. Once it started sinking into the deep sand, it was unable to extricate itself.



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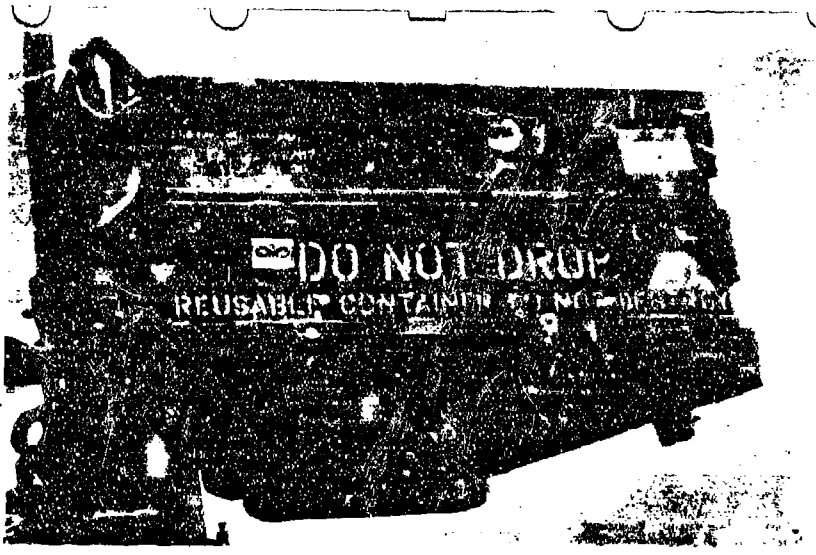

Above and below are examples of cargo which cannot be carried over bumpy ground because the forks are too short to reach well beyond the center of gravity.

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Even though the fork could be forced into the lower side of the load and that side raised and blocked, the CRF was generally unsuited for picking up loads in rough terrain.

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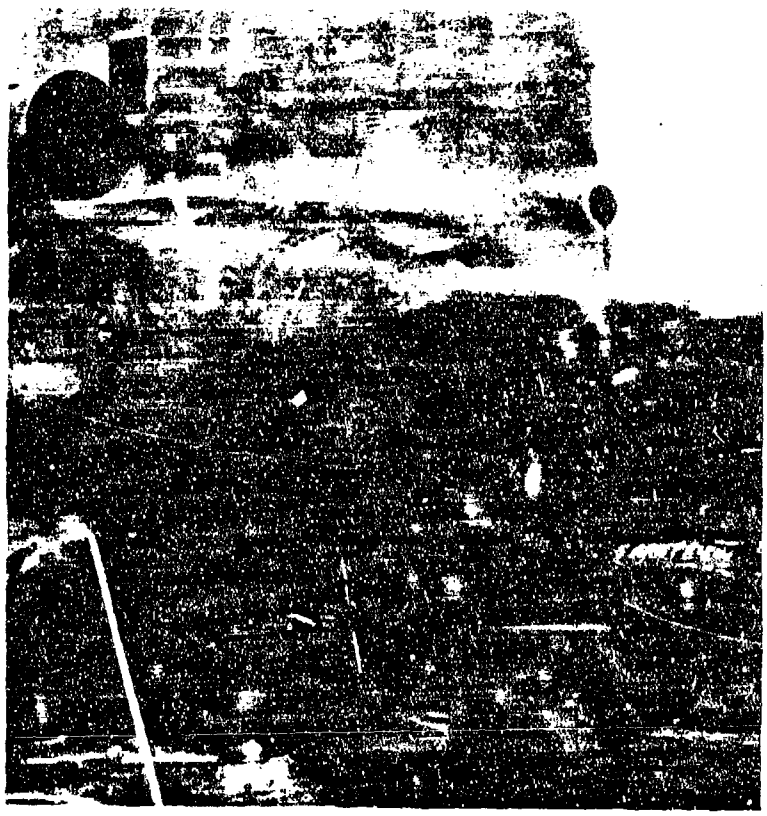

Although pallets can be brought up to the rear ramp and in some cases maneuvered onto the rear loading ramp, the CRF is generally unsuitable for use with the CH-47.

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ANNEX B

RECOMMENDATIONS FOR MODIFICATION
OF THE
CLARK RANGER FORKLIFT

1. The following minor modifications affect the safety of operation of the CRF, would improve the operator's ease of operation, and should be made prior to quantity purchase of the CRF.

a. Clutch and Brake Pedal

The clutch and brake pedals should be lowered and the travel from top to bottom positions reduced. The present design is unsuitable for operators over six feet tall and less than desirable for those under six feet tall (see appendix 1).

b. Hand Brake

The hand brake should be relocated to a position under the operator's seat where it could be easily reached by the operator's left hand throughout its range of travel (see appendix 2).

2. The following modifications would reduce user problems and increase reliability.

a. Ignition Switch

The ignition switch should be moved to a position clearly visible to the operator and marked to reduce the chance that the operator will leave it on.

b. Battery

The battery box should be redesigned to accept a common shaped battery, thereby improving replacement availability.

c. Generator, Starter, Voltage Regulator

The generator, starter, and voltage regulator should be replaced by types which have demonstrated their reliability in the tropics.

d. Electrical Wiring

Electrical wiring and terminals should be coated to prevent deterioration in tropical climates.

e. Fuel Tank Filler Neck

The fuel tank filler neck should be enlarged to accept all standard fuel nozzles.

f. Tires

An improved tread should be used to provide better traction in soft sand and muddy inclines.

g. Lubrication Point

A lubrication point should be installed at the clutch pedal torque tube mount bracket bearing immediately left of the steering column support bracket. When the bronze bushing gets dry and dusty, the clutch pedal tends to hang (see appendix 3).

h. Forks

The flotation of the forks back and forth along their support bar could be eliminated by a simple locking clip attached to the horizontal support bar.

i. Attachment Bolt Modification

A provision should be made for locking the two bolts which secure the rear deck cover to the main frame.

j. Synchronization of Gears

The forward-reverse gear should be redesigned to provide easier shifting.

3. The following major modifications, although not essential for satisfactory performance in improved areas, should expand the area of operations for the CRF and provide improved performance.

a. Suspension System

Modification of the suspension system to reduce the severe vibrations experienced in rough, "choppy", or "washboard" type surfaces would increase the practical operating area of the CRF. Further, it would reduce the chance of injury to the operator when inadvertently hitting a

bump or hole. It would allow increased speeds with loads over moderately rough surfaces and reduce turn-around time.

b. Forks

An extension of the forks would provide the CRF with an increased load-handling capability. A fork extension could be designed which would not limit the maneuverability of the CRF in tight places by the increased fork length when the longer length was not required.

c. Load leveling Capability

An increase in the rough terrain mission capability could be gained by providing a load-leveling capability to the forks. This would give the capability of picking up loads on uneven ground when the load is sitting at a different angle from the forklift.

d. Mast Height

The capability of the CRF could be further expanded by reducing the height of the mast so that it would fit under the cargo compartment overhang of the CH-47. The CRF then could be used to load and unload the CH-47.

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The positioning of the brake and clutch pedals and the large amount of travel required by their design make them awkward and tiring to use. As can be seen in the photograph, the knees can be parted to keep them from getting stuck under the wheel. However, to preclude the possibility of getting the knees stuck under the wheels during a critical operation, it is desireable that this situation be alleviated.

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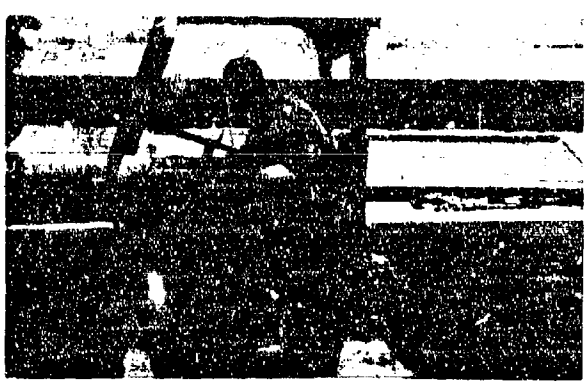

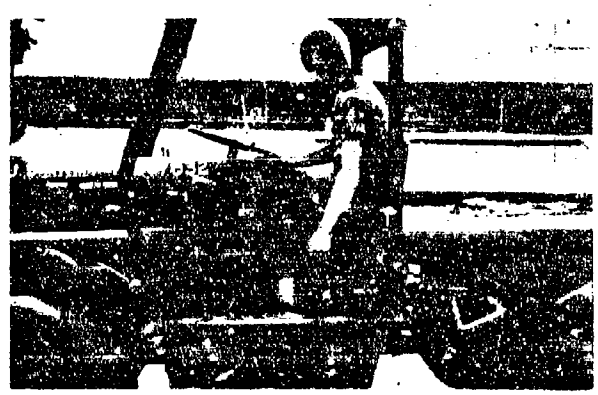

Three separate motions are required to engage the parking brake because of the awkward position and the portion of its travel arc where the resistance is greatest. It would be more practical to locate it below the seat as indicated in the lower right picture.

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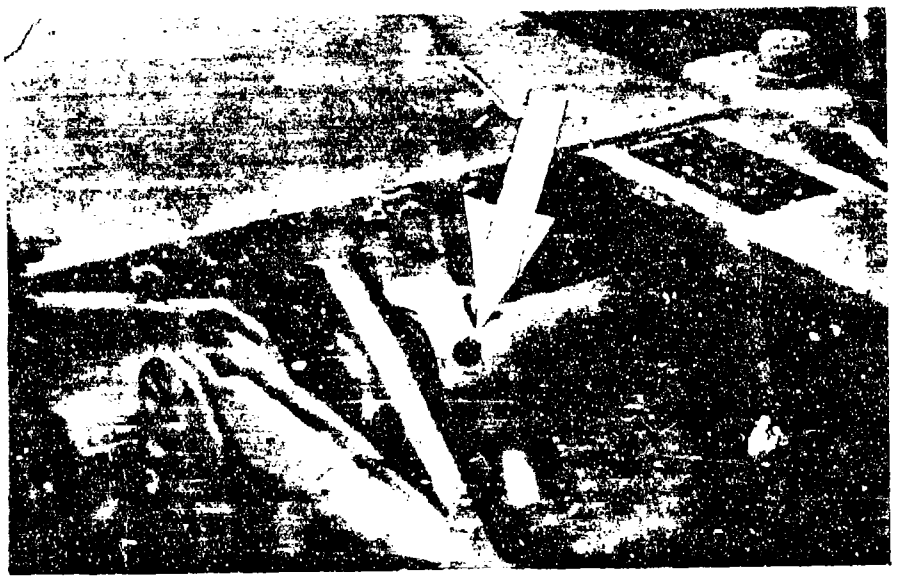

Dust ·king its way into the bushing tends to make the clutch pedal stick. A simple hole drilled to the bushing through the support bracket allows the bushing to be purged with a grease gun.

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13. ABSTRACT

This report evaluates the suitability of the Clark Ranger Forklift (CRF) for use in Vietnam. The CRF was evaluated by units of the 1st Aviation Brigade throughout Vietnam. The CRF performed well, was rugged, easy to operate, and appeared to be reliable. It was determined that the CRF was suitable for use in areas which are fairly even and free of deep soft sand.

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